Board independence, corruption and innovation. Some evidence on UK subsidiaries

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BOARD INDEPENDENCE, CORRUPTION AND INNOVATION. SOME EVIDENCE ON UK SUBSIDIARIES.

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Abstract

In this paper we test the hypothesis that independent boards can insulate a company from the detrimental impact of corruption on its performance (proxied by innovation). To this purpose, we have estimated an innovation production function that links innovation outputs to innovation input (namely investment in R&D) on a sample of manufacturing subsidiaries controlled by British multinationals and located in 30 countries. Our analysis covers the period 2005-2013. After controlling for the subsidiary's characteristics (including the ownership structure and whether the main shareholders are from Common Law countries), we find that independent boards may mitigate the negative impact of corruption on innovation as subsidiaries located in more corrupt countries and with more independent boards tend to invest more in R&D and register more valuable patents. These results still hold after controlling for the average age of the directors, the proportion of directors with no local business affiliations and government effectiveness.

Keywords: Board Independence, Corruption, Affiliates, Innovation.

1. INTRODUCTION

The influence of the board structure on the performance of a company is one of the most active research areas in corporate finance (Dahya et al., 2008; Aggarwal et al., 2009 and Bruno and Claessens, 2010; Black and Khanna, 2007, Dahya and McConnell, 2007). According to Fama and Jensen (1983), the board has two main functions: monitoring the senior management to protect the company against fraudulent behaviour and advising the management on the strategic direction taken by the company. The optimal board structure is then a function of the costs and benefits associated to the two functions, given the characteristics of the firm and its economic environment (Kim et al, 2007).

Conventional wisdom suggests that boards with a large proportion of outside directors (i.e. more independent boards) may be effective monitors and have a positive impact on the company's performance. Empirical research tends to support this view. Indeed, cross-country studies have shown that board independence is significantly and positively related to firms' performance (Dahya et al., 2008; Aggarwal et al., 2009 and Bruno and Claessens, 2010) while single-country studies have shown that the independence of the board is particularly relevant to companies that are located in countries with weak protection of the investors rights (Black and Khanna, 2007, Dahya and McConnell, 2007) consistently with the view that internal governance mechanisms (such as board structure in this case) are responses to firms' contracting and operating environments. Unsurprisingly then, it is commonly believed that the independence of the board is a key feature of a well-run company (Liu et al., 2015) and several countries have adopted legislation demanding higher representation of outsiders on the boards of publicly traded companies[1].

Are the benefits of an independent board limited only to the protection of the minority shareholders from the risk of expropriation? In this paper, we argue

[1] See the Sarbanes-Oxley Act for US. In the UK, the corporate governance code requires firms to appoint to their boards a majority of independent directors.

there are additional benefits that may accrue to a company from having an independent board. More specifically, we suggest that independent boards can mitigate the impact of corruption on business performance. Corruption is usually the outcome of dysfunctional institutions and it can have a disruptive impact on a company: for example, corruption increases the costs of obtaining loans and licences (Fan et al., 2008; Lemma, 2014) and reduces the propensity to invest in innovation (Mahagaonkar, 2008). Although the impact of corruption is well understood, the mechanisms that companies can use to mitigate the risk of corruption are less so. Some authors have pointed out that in weak institutional environments the design of the internal governance mechanisms is critical for a company to mitigate the effects of the local institutions and perform well (La Porta et al, 1998; Klapper and Love, 2004). These typically include the board of directors and while the notion that boards can shelter companies from corruption is accepted, very little is known about the desirable board structure in corrupt countries. In this paper we suggest that independence from the top management is the key feature of boards that are effective in insulating a company from corruption.

For our analysis, we focus on the board of directors among multinational subsidiaries. This is an interesting group of firms to analyse for several reasons: first, multinationals tend to be very sensitive to the levels of corruption in the host country. Indeed, corruption tends to increase the costs of operating abroad while decreasing the return on foreign investment (Wei, 2000; De Rosa et al., 2010). Ultimately, multinationals prefer not to invest in countries characterised by high levels of corruption and if they do so, they prefer partnerships to equity modes. Second, because of the strategic nature of FDI, multinationals use a variety of corporate governance mechanisms to control their investment and ensure that they are not expropriated either by local managers or by other shareholders. Therefore, it is expected that boards may play a key role in the structure of the governance that multinationals adopt when investing abroad although there is no evidence on whether there is a desirable board structure in these cases. Finally, recent high-profile cases of corruption among multinational subsidiaries[2] have put the board structure under the limelight and therefore an analysis of whether the board structure is an effective mechanism to insulate affiliates' performance from corruption is rather timely.

Against this background, the main purpose of this paper is to explore whether in more corrupt countries subsidiaries with more independent boards perform better than subsidiaries with less independent boards after controlling for a set of characteristics of the subsidiary and of the board itself. In a set of robustness tests, we explore whether it is really independence that matters for a well performing company in a corrupt country or rather there are other characteristics of the board that are equally important. We therefore test whether the relationship between independence of the board and R&D intensity still holds after controlling for other characteristics of the directors. In particular we focus on the directors' average age (as a proxy for their experience) and on the connections they have with foreign companies. This way we eventually provide some useful empirical evidence on the desirable structure of the directors' boards among affiliates in corrupt countries.

Unlike previous papers in this area, we focus on innovation as our indicator of business performance rather than on the company's financial performance or its market value. This is in itself a novelty of the paper. Although a few papers have analysed the relationship between independence of the board and firm performance, hardly any has focused on innovation as a business outcome. Still innovation underpins business growth and eventually financial performance as innovative firms tend to be more productive and profitable. Eventually, they perform better on the financial markets and can attract external funding. In addition, the relationship among innovation and corruption is relatively underexplored. Whether innovation is negatively associated to the level of corruption in a country is unclear. It is commonly argued that innovation can be

[2] The bribery scandals that have involved Walmart in Mexico and Avon in China have highlighted the weaknesses of their governance. Also, empirical evidence suggests that affiliates in foreign countries are as likely as their domestic counterparts to engage in corruption (Hellman et al., 2002). The Transparency International Bribe Payer Index shows that companies from leading exporting countries are the most likely to pay bribes in foreign countries. Georgeiev et al. (2011) show that affiliates tend propensity to pay bribes in sectors that offer higher rents.

stifled in corrupt countries as bribes can subtract resources that could be otherwise used by companies to invest in R&D[3]. The main argument is that innovation is a complex process with uncertain output (i.e. the actual invention) and corrupt managers can exploit this uncertainty to divert resources for their private benefit and allow R&D projects to fail while blaming the uncertainty of the process for the failure. However, it has also been argued that bribes can reduce the risk of bureaucratic expropriation with the result that companies may be more willing to invest in R&D projects with more uncertain outcomes. Interestingly, Schleifer and Vishny (1993) find that corrupt firms would often report having advanced technologies even though they are not necessary.

To model the relationship among corruption, propensity to innovate (or number of innovations) and internal corporate governance mechanisms (i.e. ownership concentration and structure of the board), we estimate an innovation production function that links innovation outputs to innovation input (namely investment in R&D). We use two measures of innovation outputs: the number of patents registered with the European Patent Office (EPO) by the affiliate in a given year and the cumulated sum of forward citations that the patents have received. Patents are a common indicator of business innovation. However, not all the patents have the same value as some innovations may be more valuable than others. For these reasons, we use the number of forward citations (i.e., the citations received by the patents registered by a firms divided by the number of registered patents) as an indicator of the patents' quality. Earlier studies have shown that forward citations are positively correlated with the monetary value of the patent (Harhoff et al., 1999; Lanjouw and Schankerman, 2001; Trajtenberg, 1990), supporting the notion that that forward citations are a good indicator of the value of a patent.

Our innovation input is the investment in R&D carried out by the affiliates in our sample. However, the innovation literature has established that not all

[3] Mahagoankar (2008) provides some evidence showing that corruption can affect negatively product innovation.

companies invest in R&D and that R&D-performing firms are a self-selected group. In other words, there exists a problem of self-selection in the sample that needs to be addressed when estimating the innovation production function. In addition, we also take into account the fact that investment in R&D is lumpy and that there may be a lag between the year the investment in R&D takes place and the year a patent is registered. In other words in our sample there may be firms which may register a patent but may have not performed R&D over the years covered by our sample. To be able to address these two issues, we first model the affiliate-level investment in R&D where the self-selection into R&D investment is explicitly modelled; this is then followed by the estimation of an innovation production function where the predicted R&D intensity (calculated from the first set of equations) appears as the innovation input. We assume that the affiliates' characteristics influence the self-selection into the R&D investment while the R&D intensity is driven by level of corruption in the host country, the structure of the board (namely, its size and independence) and the level of foreign ownership (proxied by a dummy variable). In our main specification, we interact the indicator of board independence with the level of corruption to gauge the extent to which in more corrupt countries, subsidiaries with more independent boards tend to invest more in R&D. The literature on the board structure and on the drivers of its independence, in particular, suggests that R&D intensity (taken as a proxy of the complexity of a company's operations) may actually drive the structure of the board with the result that the indicator of board independence cannot be considered exogenous to the affiliates' R&D intensity. We therefore use an instrumental variable (IV) estimator (while still controlling for the potential sample selection) to estimate the relationship between the affiliates' R&D intensity, board independence and perceived corruption in the host country; the board independence (and its interaction with the level of corruption in the host country) is instrumented by three variables: the proportion of foreign executives in the host country working in other multinationals belonging to the same industrial sector of the affiliate under observation, the number of multinationals operating in the region and the country the affiliate is located and the proportion of female directors below fifty years old working in other multinationals that operate in the same industrial sector the affiliate belongs to.

Our empirical analysis has been conducted on a data-set of 4,100 UK affiliates from the manufacturing sector, located in 30 countries and observed over the period 2005-2013. For each of these affiliates, we have information about the patents they have registered with the European Patent Office as well as their forward citations. We also have information about the ownership structure (i.e. the proportion of shares owned by the parent company as well as by the remaining shareholders) and the characteristics of their directors. The results show that independent boards may mitigate the negative impact of corruption on innovation: subsidiaries located in more corrupt countries with more independent boards tend to invest more in R&D. In turn they register more patents and their portfolio of patents tends to be valuable. In other words, the R&D investment in these subsidiaries tends to be more productive than what we observe among affiliates located in the same country but with less independent boards. Our results suggest that multinationals are aware of the fact that independent boards may not be effective advisors with the result that they tend to draw the independent directors from the pool of (either female or young or foreign) executives in the same industry. However, in countries with low levels of corruption, this strategy is not very successful as the benefits of having a largely independent board are smaller than the costs associated to the presence of outside directors. These results also hold after controlling for the average age of the directors, the proportion of directors with no local business affiliations and government effectiveness.

This paper contributes to the existing literature in this area in several ways. First, it shows that boards in well-performing companies located in corrupt countries have to be independent from the local management. Importantly, the paper shows that other ways of structuring the board of directors (by appointing more experienced directors or directors with no local connections) may not be as effective as independence in insulating affiliates from corruption. Second, it is the first paper that tries to assess the relevance to affiliates of an independent board together with the benefits that may accrue to them. Third, it contributes to the literature on the role of the operating environment in conditioning the structure of the board in companies with complex and technical operations (like R&D performing firms). While theory (Raheja, 2005; Adams and Ferreira, 2007) suggests that business performance increases in the insiders' fraction among R&D intensive firms as sharing information with outside directors can be expensive, the evidence supporting this hypothesis is contradictory[4]. Our results show that the characteristics of the business and institutional environment (here proxied by the levels of corruption in the host country) may drive the preference of R&D performing firms for different ways of structuring the board.

The structure of the paper is as follows. Section 2 offers a brief summary on the main themes and results from the literature on multinationals, corruption and internal mechanisms of corporate governance. Section 3 presents the empirical specification of the innovation production function as well as the data-set and the variables. The results are illustrated in Section 4 while some concluding remarks are offered in Section 5.

2. CORRUPTION, MULTINATIONALS AND BOARD INDEPENDENCE

Understanding the impact of corruption on economic growth and other economic outcomes has always been a key research area in several disciplines for decades now (see Aidt, 2009 for a useful survey). Corruption is a multifaceted phenomenon (Hellman et al., 2001) which may include the bribing of public officials, kickbacks in public procurement and misappropriation of public funds. Definitions of corruption vary a lot[5] but there is agreement that what really defines corruption is the fact that public power is misused for private benefit in an illegal fashion (Mauro, 1998; Treisman, 2000; Reiter and Steensma, 2010). A feature that links all the corrupt practices is that they

[4] See Adams and Ferreira (2007) and Boone et al. (2007). For example Linck et al. (2008) find that R&D intensity and board independence are positively related while Coles et al. (2008) find that R&D performing firms have a preference for inside directors.

[5] Friedman et al. (2000) emphasises the costs to businesses and to the society in general of corruption while Nye (1989) stresses the misuse of power for private benefits.

generate rents that can be either shared between firms and corrupt officials or entirely appropriated by corrupt bureaucrats[6]. As for the origins of corruption, there is consensus that corruption tends to be an expression of dysfunctional legal institutions and poor public governance quality leading, in turn, to opaque work practices within government departments (see Hellman et al, 2010).

Corruption is believed to be detrimental to a country's economic outcomes for several reasons: it has a negative impact on the adoption of new technologies, slows down the process of capital accumulation and (last but not the least) harms the country's capability to attract foreign direct investment (FDI) (Krusell and Rios-Rull, 1996; Acemoglu and Verdier, 1998; Aidt et al., 2008). This last point is hardly surprising: high levels of corruption are usually associated to institutional environments with poor governance and weak protection of property rights, factors that are usually perceived unfavourably by foreign investors (Egger and Winner, 2005). As corruption weakens the effectiveness of the country-wide institutions in protecting the interests of foreign investors and may expose them to the risk of expropriation, it may increase the operational cost of investing abroad[7] (see for instance Hines, 1995, Wei, 2000, Asiedu and Freeman (2009), Batra et al. (2003), Gaviria (2002)[8]), reduce the return to the foreign investment (Bhaumik et al., 2009) and eventually harm their performance (De Rosa et al., 2010). The press and the academic literature offer plenty of examples of how corrupt practices in host countries can damage the

[6] According to Hellman et al. (2001), this is the key difference between the two main types of corruption, namely state capture (where firms can affect the formulation of the laws and regulation through private payments to public officials and politicians) and administrative corruption ("petty" forms of bribery in connection with the implementation of laws, rules and regulations).

[7] Wei (2000) suggests that bribes can be considered additional taxes that increase the uncertainty of returns to foreign investment.

[8] Multinationals may be banned from operating in foreign countries: in 1996, five multinationals were banned by Singapore from bidding on any government projects as their agent was found guilty of paying bribes. For instance, in a survey-based study that involved firms drawn from 20 countries in Latin America, Gaviria (2002) assesses the effect of corruption on firm performance and concludes that corruption substantially reduces sales growth, lowers investment and employment growth. In a similar vein, using firm-level data from 46 countries, Lee and Ng (2006) demonstrate that firms from more corrupt countries trade at significantly lower stock values than is the case for firms from less corrupt countries and also that corruption has a significant economic consequences for shareholder value.

parent company[9]. Although these practices have been justified by the suggestion that they facilitate the operations of a company in a foreign country[10], survey data effectively dismantle this notion by showing the full disruptive effect of corruption on businesses (either foreign or domestic)[11]. Unsurprisingly, empirical research on the relationship between the level of corruption in the host country and foreign direct investment finds that foreign investors prefer not to invest in countries where the levels of corruption and rent-seeking are too high and if they do so multinationals may prefer partnerships and non equity modes[12] to a fully controlled subsidiary so that they could still benefit from having access to foreign markets but without bearing the hidden costs associated to operating in a corrupt environment (see Straub, 2008; Javorcic and Wei, 2009; Demirbag et al., 2010).

Still, multinationals do invest in corrupt countries and in a variety of equity modes[13]. One reason for this preference for equity modes (even if it involves investing in corrupt countries) is that for most multinationals, partnerships and greenfield/brownfield investments are not perfect substitutes as the literature tends to assume (Tekin-Koru, 2013). While partnerships provide rapid access to a foreign market and allow to exploit quickly existing synergies between local firms and affiliates, greenfields allow a multinational to fully appropriate the benefits from the investment abroad. This point may be particularly relevant to R&D performing firms or to technological firms which may want to protect their

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[9] See for instance the impact that the Walmart bribery scandal in Mexico has had on the parent company (refer to Heineman, 2014 for further details). Pantzalis et al. (2008) find that the valuation of multinationals is negatively affected by the expansion into corrupt countries.

[10] This is the so-called "Grease the wheel" hypothesis. First suggested by Leff (1964), this hypothesis suggests that corruption facilitates trade and promotes efficiency by allowing companies to circumvent cumbersome regulations. In reality, Kaufman and Wei (1999) find that firms that pay more bribes face more red tape.

[11] An old survey of 3600 firms in 69 countries conducted for the 1997 World development report highlight how paying bribes in exchange for favour or basic public services is a way of conducting business in some countries. However, the interviewed also pointed out there is no guarantee that the promised service or favour will be delivered and the real consequence of paying a bribe is that it paves the way to additional requests (World Development Report, 1997).

[12] Non equity modes refer to exports and contractual agreements such as licensing, franchising and R&D contracts (Peng, 2009). Equity modes include joint ventures and wholly-owned subsidiaries. The first consists of a sharing agreement between an MNE and a local firm. In the second case, they include both Greenfield investments involving the establishment of a new firm and the acquisition of existing firms.

[13] See for instance the investments of Ford, General Motors and Mars in Russia. In all the three cases, the parent company has decided to invest in Russia via either a brownfield or a greenfield.

intellectual capital and fully appropriate the return of the investment in R&D[14]. If this is the case, what internal strategies are available to multinationals that want to invest in a foreign country via an equity mode but want to insulate the performance of their subsidiaries from corruption?

A few papers have pointed out that the design of the internal corporate governance mechanisms among subsidiaries is the main channel through which foreign owners manage to reduce the risk of being expropriated by corrupt managers and bureaucrats (see Mani et al., 2007 for instance). This is unsurprising: it is well known that weak legal institutions require companies to have in place a strong internal governance structure to mitigate the adverse effects of the poor institutional quality[15]. The starting point of this literature is that the managerial discretion which is inherent to the manager's position, combined with the existence of the manager's own interest and the separation between ownership and control, can provide a gateway for corruption into a company. For instance, a manager may agree to pay a bribe so that the company may obtain a contract with the result that the manager's remuneration can increase. The corporate governance literature is dominated by the debate on the implications of this split for the owners and several mechanisms have been suggested to re-align the interests of managers to those of the owners (or shareholders). The main implication is that as long as corruption is linked to managerial discretion, the same internal governance mechanisms that can limit or control managerial discretion may also insulate companies from the hidden costs of operating in countries with high levels of corruption.

There are two main internal corporate governance mechanisms that are typically used for this purpose: 1) ownership concentration and 2) the structure of the board of directors. A lot is known about the ownership patterns of

[14] Javorcik and Wei (2009) find that technological advanced multinationals may prefer fully owned subsidiaries to avoid leakages of know-how. Equally, Marin (2005) finds that R&D intensive subsidiaries tend to be fully owned by multinationals.

[15] La Porta et al. (1999) suggest that in countries with weak investor protection rights, stockholders may have to rely on other means of protection. Klapper and Love (2004) find that in countries with weak legal governance, firm-level corporate governance mechanisms can compensate for ineffective enforcement by establishing good corporate governance and credible investor protection.

companies located in countries with high levels of corruption[16]. For instance, Du (2008) finds that corruption leads to a higher degree of corporate ownership concentration while Lemma (2010) finds that in more corrupt countries concentrated ownership and block shareholding are the preferred ownership structures. Equally a lot is also known about the ownership structure among multinationals' subsidiaries in corrupt countries (see Brouthers, 2002; Gatignon and Anderson, 1988; Mani et al., 2007; Meyer et al., 2009). The preference of multinationals for concentrated ownership when investing in corrupt countries is well documented (Mani et al. 2007). First, since foreign direct investment is characterised by strategic interests, by a high degree of commitment and ex post immobility (Aguilera and Jackson, 2003), the choice of the ownership structure becomes critical (Carr et al., 2001). Second, in corrupt countries with severe corruption, the enforcement institutions are weak and the interests of the minority shareholders are less likely to be protected from expropriation while only large shareholders may have the incentives to monitor the local management[17].

At the same time, while the concentration of ownership is seen as the solution to the main agency problem, there is no guarantee that this mechanism alone may protect the subsidiary from the negative impact of corruption on its performance. A large literature has now highlighted the dangers of concentrated ownership to the performance of a company: in a seminal paper, Shleifer and Vishny (1997) argue that firms with concentrated ownership tend to be opaque organisations and that the dominant shareholders may still damage a company's performance by underinvesting so to extract private benefits as majority shareholders are less likely to face scrutiny from other shareholders (see also Bhaumik, Driffield and Pal, 2010 on this point). The costs associated to concentrated ownership may be particularly relevant to companies operating in corrupt environments as majority owners may now be inclined to engage with

[16] In a seminal paper, La Porta et. (1999) find that concentrated ownership and legal protection of investors' rights are substitute corporate governance.

[17] See Young et al. (2008).

corruption (similarly to what managers would do) and shift the cost of corruption onto minority shareholders.

It is in this context that the board structure has been identified as an additional internal governance mechanism that multinationals can use to insulate affiliates from the impact of corruption. Fama and Jensen (1983) pointed out that as the ultimate legal authority in a company, the board has two main functions: on the one hand, it has to scrutinize the top management and veto projects that are not value-maximizing (monitoring function) while on the other hand, it has to draw on its expertise to support the senior management and give advice on the strategic direction of the company (advising function) (see Banes et al., 2007; Linck et al., 2008 and Coles et al., 2008 as well). When performing either function, the board can be an effective defence against the emergence of corrupt practices within the company: as a monitor, it is in a position to identify and veto projects that can only be vehicles for illicit payments while as an advisor, the board can help the management to better understand the local institutions and norms as well as their pitfalls. It is usually assumed that boards with a large fraction of independent directors are effective monitors as they are less susceptible to be influenced by the senior managers. In addition, outside directors may bring useful knowledge that is particularly relevant to foreign companies. All this supports the conventional wisdom that independent boards may be preferable when investing abroad. Indeed, empirical research suggests that independent boards are desirable in countries with poor legal institutions. Independence of the boards is a key feature of a well-managed company in countries where the minority shareholders' rights are not adequately protected by the local legal system (See Dahya et al., 2008; Aggrawal et al. 2009). Claessens et al. (2006) and Bruno and Claessens (2010) have found that the degree of independence of the board is positively associated with the good performance of a company. This result has also been confirmed by studies that have focused on individual countries like India, U.K. and Korea (Black and Khanna, 2007; Dahya and McConnell, 2007; Bruno and Claessens, 2010; Black and Kim, 2012)[18].

[18] Yeh and Woidtke (2005) examine determinants of board composition and firm valuation as a function of board composition in Taiwan. They find that when the board is dominated by

Finally, in a robustness test Kim et al. (2007) find that in countries with less corruption, companies tend to have fewer independent directors. Although the authors do not offer any interpretation of this finding, this result suggests that there is a relationship between board structure and corruption and that the level of corruption may potentially mediate the relationship between board structure and business performance.

However, compared to inside directors, outside directors offer disadvantages that can influence negatively their effectiveness in a board. First, unlike inside directors, outside directors do not have a complete understanding of the company's daily operations and the process of acquiring information on the projects put forward by the senior management is costly. Second, they tend to have generic knowledge of the business environment that may not necessarily apply to the specifics of the company they overview. The implication is that when selecting the board, owners face a trade-off: on the one hand they need to appoint a board which is sufficiently independent from the top management (so it can be an effective monitor) and on the other hand, they need to select a knowledgeable board which can be an effective advisor to the senior management team. Theory suggests that companies balance this trade-off by taking into account the nature of their operations. Indeed theoretical research suggests that firms with complex operations (like R&D intensive companies or companies dispersed geographically) will have a higher proportion of insiders

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members who are affiliated with the controlling family governance is poor. On the contrary, it is good when the board is dominated by members who are not affiliated with the controlling family. Consistently with this finding, relative firm value is negatively related to board affiliation in family-controlled firms. Dahay and McConnell (2007) examine the relation between outside directors and corporate performance in the UK companies between 1989–1996, a period during which the Cadbury Report required companies to have more outside directors on publicly traded companies' boards. They show that, following the new regulation, companies that add ouside directors exhibit a significant improvement in operating performance. Similarly, the positive role of independent directors on firm performance has been demonstrated in studies of Korean firms (Black and Kim, 2012; Choi et al., 2009) . Daya et al. (2008) examine the relation between corporate value and boards comprised of independent directors, in companies with a dominant shareholder. They find a positive relationship especially in countries with weak legal protection for shareholders. They show that a dominant shareholder can offset the documented value discount associated with weak country level shareholder protection, through the appointment of an independent board. Bruno and Claessens (2010) analyse the interaction between legal regimes and firms' corporate governance practices and find evidence of the value to large companies that rely on external financing, of over-regulation and governance practices.

on the board as inside directors can provide a better advice (Raheja, 2005; Adams and Ferreira, 2007). Empirical evidence on this point is though mixed: Liu et al. (2015) have analysed the relation between board independence and firm performance and find evidence that the degree of board independence is positively related to firm performance, especially in government-controlled firms and in firms with lower information acquisition and monitoring costs. However, Linck et al. (2008) find that R&D intensive firms have a preference for independent boards. Interestingly, Coles et al. (2008) find the opposite result. Another study has estimated the relationship between innovation performance and board independence in a cross-section of 318 listed companies in China and found there is only a small correlation between innovation performance and independence of the board (Qianbing and Pingping, 2010) suggesting that independent boards may not be that important in innovative firms. These results suggest that when multinationals have to structure the boards of their network of affiliates, they have to strike the right balance between the quality of the advice the affiliates' senior management team receives from the directors and their monitoring intensity (which is directly linked to the independence of the board). This is particularly relevant to R&D performing affiliates that may be in need of technical advice from their board.

What conclusions can we draw from this survey? First, consistently with the fact that corruption and poor quality institutions go hand in hand, corruption tends to shape the choices that all firms (both local and foreign) make in terms of their internal corporate governance mechanisms. Second, although ownership concentration is considered by multinationals the main mechanism through which the agency problem between management and owners can be solved in a foreign country, in reality the structure of the board and in particular its independence may potentially matter to firms, particularly if they are located in corrupt countries. Third, very little is known about the desirable structure of the board among multinationals' subsidiaries. The literature seems to suggest that the independence of the board is the key feature of a well-performing subsidiary in a corrupt country. However, an independent board may not be the best advisor if the affiliate has very complex operations or performs R&D as outside directors may lack the necessary technical knowledge. If so, how do multinationals manage the trade-off between the quality of the advice from the board and their monitoring intensity? Are there other characteristics of the directors that are optimal from the standpoint of the owner of the company? Our empirical analysis will try to shed some light on these unresolved issues.

3. THE EMPIRICAL MODEL, DATA AND VARIABLES

3.1 The innovation production function: the empirical specification

As mentioned in the Introduction, this section is devoted to the description of the empirical model we use to estimate the firm-level innovation production function (Griliches, 1990). To this purpose, we distinguish between innovation outputs (usually number of patents) and the innovation input (proxied by a firm's investment in R&D). The innovation production function attempts to model the relationship between the R&D investment and the innovation outputs. In our specification, we take into account the fact that not all companies invest in R&D and that R&D-performing firms are a self-selected group. In other words, there exists a problem of self-selection in the sample that needs to be addressed when estimating the innovation production function. In addition, investment in R&D is lumpy and therefore we may observe firms that may register a patent but may have not performed R&D over the years covered by our sample. To be able to address these two issues, we adopt the following approach: first, we model the firm-level investment in R&D in such way that self-selection is explicitly modelled; second, we estimate an innovation production function where the predicted (rather than the actual) R&D intensity (calculated from the R&D investment equation) appears as the innovation input. In such a way, the relationship between patents and R&D can still be investigated for those firms that have an innovation output even if they do not appear to have invested in R&D in our sample period.

By using predicted values of R&D (instead of the actual investment in R&D) in the actual innovation production function, we are implicitly using an instrumental variable approach to address the potential reverse causality between the actual innovation output and the investment in R&D. Therefore, when we specify our empirical model, we do impose some exclusion restrictions based on assumptions which are plausible from an economic standpoint. More specifically, we assume that the impact of corruption is limited to the investment in R&D while it does not influence the relationship between the innovation output and the investment in R&D. In other words we assume that corruption may reduce the subsidiaries' incentives to invest in R&D (and its intensity) as funds may be re-routed towards illicit transactions but not the incentive to register a patent once the investment in R&D has taken place and has generated a patentable innovation.

Our empirical model is formalised in two stages. In Stage 1, we model the firm's decision to invest in R&D as well as its R&D intensity. In Stage 2, we estimate the innovation production function and we assume that the innovation output is conditional on the predicted R&D investment and other firms' characteristics. We will now analyse each stage in more detail.

Stage 1: the first two equations model simultaneously the firm's decision to invest in R&D and its intensity using a sample selection model. The decision to invest in R&D is governed by the following equations:

$$is_i = 1 \text{ if } is^* = w_i\alpha + \varepsilon_i > 0 \quad i = 1,\ldots,N \qquad (1)$$
$$is_i = 0 \text{ otherwise}$$

Where is^* is an unobservable latent variable whose value determines whether the firm invests in R&D, *is* is an observed indicator which equals zero for firms that do not invest in R&D and one for R&D performing firms. *w* is a vector of variables explaining the investment decision, α is a vector of parameters to be estimated and ε_i is an error term, assumed to be Normally distributed.

Conditional on firms investing in R&D, we observe the amount of R&D (modelled here as *isi* - i.e. the logarithm of the R&D expenditure per employee):

$$
\begin{aligned}
isi_i &= z_i\beta + e_i \text{ if } is_i \neq 0 \\
isi_i &= 0 \qquad\quad \text{ if } is_i = 0
\end{aligned}
\tag{1}
$$

where z_i is a vector of variables affecting the innovation expenditure intensity, β is the vector of coefficients and e_i is an error term. Assuming that the two error terms are distributed as a Bivariate Normal with zero mean, variances $\sigma_\varepsilon^2 = 1$ and σ_e^2, and a correlation coefficient ρ, the system of equations (1) and (2) can be estimated as an Heckman model.

We do estimate several specifications of the two equations in Stage 1. The first specification only includes the log of employees count, log of the capital intensity, log of equity, market share, age (in log) as well as industry, year and country dummies as explanatory variables for the first step (probability of reporting positive R&D). We control for the size of the affiliate as larger firms tend to be more inclined to invest in R&D as they can easily cover the sunk costs of the investment unlike small firms (Cohen and Levin, 1989; Cohen and Klepper, 1996). Equally, the empirical literature suggests that older firms tend to invest more in R&D than younger ones because of the specialist skills that younger firms may lack (see for instance Zahra *et al.*, 2005). We also control for the affiliates' capital intensity that is positively correlated to the propensity to invest in R&D among large firms. We also control for the market share of the subsidiary as a few papers have suggested that firms with a large market share innovate more so to maintain their position in the market (Blundell et al., 1999). The availability of equity capital is known to be positively correlated to investment in R&D as this has high upfront costs that tend to be met by available financial resources (i.e. equity) rather than by external funding (Mueller and Zimmermann, 2014). Finally, industry dummies capture the technological characteristics of the sector which may influence the firm-level propensity to invest in R&D (or its intensity)[19] or the industry-level appropriability regime (see Mairesse and Mohnen, 2002) while country dummy control for the time-

[19] This way, we can control for the technology-pull factors that may influence the investment in R&D.

invariant characteristics of the host country that may be correlated to either the propensity to invest in R&D or its intensity (like the legislation on the protection of a firm's intellectual property or the time-invariant characteristics of the corporate governance system in each country).

In a second specification, we include a variable indicating the number of subsidiaries controlled by the parent company so to control for potential economies of scale within the local network of affiliates. We also attempt to control for the fact that firms which have been successful in transforming R&D investment in high-value patentable inventions are also more likely to continue to invest in R&D (so called "success-breed-success" hypothesis) and we do so by introducing a set of dummies taking the value of one if any of the patents registered by each affiliate has been cited by another patent in the previous years.

In the final specification, we introduce a dummy variable taking the value of one if the company has collaborated with an external organisation for the development of a patentable invention and zero otherwise. Several authors suggest that collaboration stimulates further R&D investment by allowing firms to share costs and internalising knowledge spillovers (see Kamien *et al.*, 1992). This variable also allows to control for the use of external sources of knowledge when investing in R&D (Crespi and Zuniga, 2012; Griffith *et al.*, 2006). Finally, we introduce our variables of interest: a dummy taking the value of one if the companies that own more than 50% of the subsidiary's shares are from Common Law countries[20], an indicator of the board independence, the perceived level of corruption in the country and the interaction between the last two variables. As majority shareholders may use ownership concentration to insulate the affiliates from the effects of corruption, we expect that in corrupt countries owning more than 50% percent of the affiliates' shares is common. Therefore we interact the ownership dummy with the indicator of corruption. The variables in level and their interactions are included only in the R&D

[20] This is an important control variable as in the case of affiliates that are partially owned, the relationship between the independence of the board and the R&D intensity may be driven by the presence of a second majority shareholder from another common law country.

intensity equation as they are assumed to affect the R&D intensity (intensive margin) but not the probability of performing R&D (extensive margin). In this specification, we also control for the size of the board as a few studies have found that the size of the board can influence the performance of a company (Coles *et al.*, 2008).

Econometrically, we use a two-step Heckman selection model to estimate our three specifications. However, it can be argued that the R&D intensity of an affiliate can influence the structure of the board and therefore its independence. Indeed, there exists a large literature that points out that R&D intensity is endogenous to the board independence (see Coles et al, 2008 and Linck et al, 2008 for example). While there are no problems with the potential endogeneity in the case of the first two specifications, this is not the case with the third specification. We therefore use an IV estimator to address the potential endogeneity between the R&D intensity and the board independence (and its interaction with our indicator of corruption) while correcting for the sample selection as in Wooldridge (2010). According to the literature, a valid instrument must meet two criteria: a strong correlation with the instrumented regressors and orthogonality with the error term. We choose the following three instruments for the measure of board independence: a) the average proportion of foreign executives with no local business connections that work for other multinationals in the same 3-digit industry, country and year, b) the density of multinationals in the same region (NUTS2), country and year and c) the proportion of female executives below 50 years old who work for other multinationals in the same 3-digit industry, country and year. The rationale for the choice of these three instruments is the following. Affiliates' governance arrangements tend to be correlated with the industry average because they have similar business and technological opportunities although the industry average is unlikely to affect the individual choice that affiliates make. We focus on executives from multinationals because multinationals tend to be more complex organisations than other types of companies and therefore its directors need to have special skills and knowledge that can only be found in executives working for other multinationals. The presence in an industry and in a country of a large pool of executives with no local business connections makes it easier for multinationals to set up an independent board. Foreign executives are unlikely to have strong business links in the country they work and the same applies to young, female executives who have not had enough time to develop major business connections. At the same time, the multinational has interest in sourcing its potential directors from the same industry its affiliate belongs to so that the potential directors can provide the senior management of the affiliate with high-quality advice. Finally, the density of multinationals in a region and country wants to capture the size of the pool from which a multinational can source directors (Knyazeva et al, 2013).

Stage 2. In the second stage, we estimate the production of innovation conditional on the R&D intensity estimated in the first stage. Registered patents are our main indicator of innovation output. However, not all the patents have the same value as some innovations may be more valuable than others. For these reasons, we use the number of forward citations (i.e. the citations received by the patents registered by a firms divided by the number of registered patents) as an indicator of the patent quality in line with earlier papers which have shown that forward citations are positively correlated with the monetary value of a patent (Harhoff et al., 1999; Lanjouw and Schankerman, 2001; Trajtenberg, 1990).

As the innovation output is a count variable, the OLS estimates are likely to be biased and produce negative predicted values. The baseline model that allows to deal with count dependent variables is the Poisson model which assumes equi-dispersion (mean equal to the variance) of the variable of interest. This property is often violated with innovation data (either patents or citations), which are generally characterized by over-dispersion. Therefore to estimate the innovation production function, we use the negative binomial regression model which allows the conditional variance of the dependent variable to be a quadratic function of the conditional mean.

The key independent variable in Stage 2 (and appearing in all the equations of Stage 2) is the predicted value of the log of the innovation expenditure intensity (derived from the first stage estimates). As mentioned above, this way the model takes into account the fact that the innovation expenditure is endogenous to the production of innovation. Like in Griffith et al. (2006), the predicted values from the first stage estimation computed for all firms (taking into account the probability that their R&D expenditure is observed) are used to proxy innovation effort in the innovation production function. This approach assumes that a firm that reports no R&D expenditure may have still have some informal expenditure related to innovation.

The innovation production function shares with the equations from Stage 1 some independent variables, like the employee counts, age, capital intensity and the dummies for past patents/citations. The rationale for including capital intensity and the dummies for the past patents/citations among the regressors of the R&D equations is quite similar to the one offered in the previous stage. As for the other regressors, older and larger firms are more likely to register patents (which may also be more valuable) as they have the necessary experience and capability to transform their R&D investment into patentable inventions. Arundel (2001) finds that large firms are more likely to patent than small firms. This is true for two reasons. First, small firms do not have the financial resources to defend legally their patent and so may be less inclined to patent and use alternative appropriability mechanisms. Second, small firms are rarely involved in cross-licensing arrangements and therefore the costs of enforcing a patent tend to be much larger for them than for large firms. Finally, we introduce industry dummies that control for sector-specific propensity to register a patent. We use the Pavitt's taxonomy to this purpose as they capture better than the standard SIC classification the industrial differences in the attitudes to patenting. Indeed, according to Pavitt (1984), firms in science-based and specialized suppliers sectors tend to use patents more than firms in scale intensive and supplier dominated sectors. Finally, year and country dummies control for time trends and for country-level differences in legal institutions.

3.2 The data and the variables

The data are from three primary sources: the Amadeus database from Bureau Van Dijk's (BvD), the European Patent Office (EPO) database and the World Bank 'Governance Matters' databases (Kaufmann et al., 2005, 1999). Our sample period goes from 2005 to 2013. Amadeus provides financial annual accounting information for over ten million companies in Europe. The annual data include 24 balance sheets items, 25 profit and loss account items and 26 ratios. The database includes the Eurostat NACE codes that allow to sort the companies according to their industrial sector. The use of balance sheet data for our analysis offers some benefits as they have to be submitted by companies every year with the result that the coverage of the sample is more exhaustive than what we would expect otherwise.

To construct the sample, we have followed the following steps. First, using the Eurostat NACE codes for the industrial sectors, we have identified a sample of UK multinational enterprises belonging to the manufacturing sector (NACE codes 11 to 33). By focusing on UK-only multinationals, we have eliminated the need to control for the additional cross-country heterogeneity due to the inclusion of companies that are affiliated to multinationals from countries other than UK. Second, we have identified the affiliates of these multinationals located in Europe and selected only those belonging to manufacturing. Among the affiliates in our sample, we have focused on those that are either fully or partially owned[21] by the parent company. We have removed some observations because of missing values in relevant variables and removed the top and lower one percent of the observations in the sample. The final dataset includes 1,390 UK manufacturing companies and 4,100 affiliates, located in 30 countries[22]. Monetary variables have been deflated by the appropriate international deflators.

[21] At least 25% of the shares of an affiliate need to be owned by the UK-based parent company.

[22] Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Russian Federation, Serbia, Slovakia, Slovenia, Spain, Sweden, Ukraine.

The EPO data are from the Worldwide Patent Statistical Database (PATSTAT), which includes patents from 81 national and international patent offices, detailed information on patents published in the EU, and citations from/to EPO and non-EPO patents, that is, backward and forward citations to other patents. We have collected data on the number of patents registered by the affiliates in our sample between 2005 and 2013 and matched to each company using the identifier provided by Amadeus.

3.2 The variables and the descriptive statistics

Affiliate-level variables

For each affiliate we have data on the number of employees, equity (the difference between assets and liabilities), fixed assets, market share and age. Market share is calculated as the ratio of the company's sales to the total 3-digit industry sales. Patents documents report the number of collaborators in the development of the patented invention. A patent can be the output of an individual firm's R&D investment or the result of a collaborative agreement among two or more firms. In the latter case, all the companies involved are listed in the patent documents. From the patent documentation, we calculate the number of organisations that have collaborated with each affiliate for the development of the patented invention and create a dummy variable taking the value of one if the company has collaborated with an external organisation for the development of an innovation and zero otherwise.

We employ three common proxies for innovation: R&D intensity, patent counts and number of forward citations received by a given patent. We define R&D intensity as the logarithm of the ratio between R&D expenditure (proxied by the investment in intangible fixed assets)[23] and fixed assets. Since patents represent exclusive rights to a particular invention (Hsu et al., 2015), patents is the standard indicator of corporate innovation. Finally, we take the number of

[23] R&D expenditure can be reported both in the balance sheet (under the item "intangible fixed assets") and in the income statement. Generally value-generating R&D expenditure is recorded as an asset.

citations received by a patent to proxy for their quality (Hall et al., 2005; Trajtenberg, 1990). Citations to patents accumulate over the years and follow a scale free distribution; only a few patents are cited repeatedly while the majority receives no citations. The citation counts are calculated as the sum of the citations received yearly by the stock of patents owned by the affiliate.

Corruption

As an indicator of corruption, we use the Control of Corruption Indicator (CCI), first introduced by Kaufmann et al. (1999) and updated by Kaufmann et al. (2005). The Control of Corruption indicator is included in the World Bank's series of governance indicators and is part of a set of six aggregate indicators corresponding to six basic governance concepts (Voice and Accountability, Political Instability and Violence, Government Effectiveness, Regulatory Quality, Rule of Law and Control of Corruption). These indicators have been used to assess how governance varies across countries and over time. Control of corruption captures the extent to which public power is exercised for private gain and captures the extent to which public power is exercised for private gain including petty, grand forms of corruption and 'state capture' by elites and private interests. It is constructed in such a way that larger values of the index are associated to less corrupt countries. Control of Corruption is essentially an indicator of the perception of corruption and although some authors argue against attempts to measure corruption perception rather than corruption itself (Olken, 2009), it remains a widely used measure of corruption (Aidt et al., 2008; Seligson, 2006). For our analysis, we have created a dummy taking the value of one if the control of corruption is larger than 1.5 and zero otherwise. Countries in this category include Ireland, Austria, Germany, Luxembourg, Norway, Netherlands, Sweden, Finland and Denmark. This way, we can capture eventual non-linearities in the relationship between corruption and the performance of the affiliates. Indeed, several papers have argued that corruption tends to have a detrimental impact on the performance of the affiliates only if the level of corruption is very high (Pal, 2013).

Information on corporate governance

From the Amadeus database, we have collected information on the composition of the affiliates' corporate boards to calculate the independence of directors. Following the Securities and Exchange Commission (SEC) rules, we define a director as independent if he/she has no business, employment, consulting or family based affiliation with the firm or any of its subsidiaries other than his/her role as a member of the firm's board. An independent director also is not in receipt of consulting or advisory fees or compensation other than those normally associated with the directorate role.[24] The proportion of independent directors in each board is then used to calculate for each affiliate an indicator of board independence relative to the median proportion of independent directors in other firms[25] in the same industry and country which are subject to the same regulations[26]. Finally, we compute the size of the board. The literature on the relationship between the board structure and company's performance suggests that large boards may be not be effective advisors and monitors because of the coordination costs associated to the management of a large board. Lipton and Lorsch (1992) and Jensen (1993) suggest there exists an optimal size of the board that is equal to 8 or 9 directors. We therefore calculate a dummy variable equal to 1 if the board of the affiliate has more than nine directors and 0 otherwise. We also compute the proportion of directors who have only relationships with companies outside the country where the affiliate (on whose board he/she sits) is located. We compute the average age of the directors (based on the year they got their first degree) for each affiliate to proxy for their experience and possibly their attitudes towards risk. Finally, we derive the gender and the nationality of each director based on their names and their prefix.

The database contains detailed information on the ownership structure of the affiliates. For each affiliate, we can identify all the shareholders and where they are headquartered. This way we can identify the shareholders from Common

[24] For details refer to the SEC Rule Release No. 34–48745 (SEC, 2003b).
[25] In this case, we have considered all firms in the country and not only the foreign affiliates.
[26] We thank the Associate Editor for this suggestion.

Law countries (and therefore with corporate governance mechanisms which are different from those employed in the countries that are in our sample) and create a dummy variable taking the value of 1 if the majority of shareholders is from Common Law countries and 0 otherwise.

Basic Descriptive Statistics

Table 1 provides the basic descriptive statistics (mean and standard deviation) by country and for the whole estimation sample. These figures offer interesting insights on how our variables of interest vary across the sample. The (average) largest values of R&D intensity tend to be recorded in Ireland and Scandinavian countries. At the same time, the lowest values are recorded for Eastern European countries although with some difference between Poland, Czech Republic and Slovakia and the remaining countries from Eastern Europe. On average, the affiliates are 22 years old and tend to be rather large with the average number of employees being 256. However, the average age of the affiliates in Luxembourg, Denmark and Russia is above the sample average while the youngest affiliates are in Lithuania, Bulgaria and Bosnia. The smallest affiliates are in Croatia (52 employees on average) while the largest one are in the Russian Federation (783 employees on average). The average number of collaborators is 1 but Swedish affiliates collaborate with 25 external organisations on average while in the number of collaborators becomes zero for eastern European countries. On average, our affiliates register 5 patents on average over the sample period. The maximum number of patents (92) is recorded in Sweden which is also the country with the largest number of external collaborators. The average sum of forward citations per firm is around 13 although the standard deviation is rather large. There is a large variation in the level of corruption among the countries included in the sample. The average value of the control of corruption index is 1.12 with the maximum being 2.55 (corresponding to Denmark) and the minimum being -1.09 (corresponding to the Russian Federation). In terms of ownership, on average 42% of the firms in our sample is controlled (i.e. the parent company owns more than 50% of the affiliates' shares) by the multinationals although this figure varies across countries: the percentage goes up to 66% in the case of Sweden and Bulgaria while it goes down to zero in the case of Lithuania. Figures 1-4 show graphically the variation (both over time and across countries) of some of the key variables in our analysis, namely the Control of Corruption index, the R&D intensity, the percentage of shares owned by the UK parent company and the board independence index. Table 2 reports the values of the correlation indexes among the main variables in our sample: the values of the indexes indicate that potential correlation among the variables is not a problem.

In terms of legal tradition, most countries in our sample belong to the civil law tradition (see Table 3) as defined by La Porta et al. (1998)[27]. We have classified the countries in our sample on the basis of the revised anti-director rights index calculated by Djankov et al. (2008)[28] (see Table 4). The (time-invariant) index summarises the extent to which legislation protects the minority shareholders in the corporate decision-making process (as of 2003) and larger values are associated to countries whose legislation is more favourable to minority shareholders. In terms of the anti-director rights index, we find that the countries in our sample score between 2 and 5 with most countries scoring between 3 and 4. Finally, we have classified the countries in our sample on the basis of their political risk (Table 5). We have used the Law and Order index which is computed by the PRS group. The index ranks the countries on the basis of the strength and impartiality of the legal system as well as on the extent to which law is generally observed in the country. The index is time-varying in principle with larger values of the index being associated to countries which are less risky. In practice, the index tends to be constant over time in most countries in our sample with very small changes recorded only for a couple of countries from Eastern Europe. For these reasons, we report in Table 5 the average value of the index for each country. Most countries in our sample have an index between 5 and 6. Most Eastern European countries score 4 while a few countries from Western Europe score 5 (with Italy being the remarkable exception to this pattern).

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[27] The index by La Porta et al. (1998) (LLSV) is not available for all the countries in our sample.
[28] This index is not available for all the countries in our sample.

These three indexes can also help understand whether local institutions shape the structure of the board. To this purpose, we have plotted the percentage of outside directors (calculated only for the affiliates that are in our sample) against each of the three indexes mentioned above i.e. the LLSV index, the revised anti-director rights index and the ICRG Law and Order index. These plots are in Figures 5-7. From Figure 5, it appears that the percentage of outside directors varies across countries from the civil law tradition while this is less so for countries from the Germanic and Scandinavian law traditions. Figure 6 plots the percentage of independent directors against the revised anti-director rights index. In this case, countries with an average value of the anti-director rights index may still host affiliates with either a large or a small fraction of outside directors. Finally, Figure 7 plots the percentage of independent directors against the ICRG Law and Order index. For each value of the index, the fraction of independent directors varies a lot across the different countries. We have calculated the correlation indexes between the board independence index and each of the three indexes. In the case of the legal tradition indicator, the correlation is 0.03 while in the case of the anti-director rights index it is equal to – 0.11. Finally, in the case of the ICRG Law and Order index, the correlation is 0.088. All in all, these are weak correlations suggesting that legal institutions alone cannot explain the different choices that firms make in terms of board structure.

4. THE RESULTS

Tables 6 and 8 present the main estimates of our model[29] with Table 6 showing the estimates of the R&D investment equations (Stage 1) while in Table 8, we report the estimates of the two counts models (Stage 2).

[29] These estimates refer to the total number of countries in our sample. However, some these countries allow two-tiered boards and to avoid the possibility that this would bias the results, we have re-run our model without these countries. The main results still hold. We have tried to control for quality of protection of the minority shareholder rights by introducing the CGI indicators but for our sample period and our countries, there is very little variation of these indicators with the result that the country dummies should be able to control for the cross-country differences in the legislation on the rights of the minority shareholders.

Stage 1. Table 6 presents a variety of empirical specifications of the R&D investment equations. The results show that the choice of a sample selection model with correlated disturbances is supported by the data. The test of significance of the Inverse Mills Ratio (IMR) shows that it is always significant across all the different models. The signs of the ratios (not shown in the table) are always positive implying that firms investing in R&D (even though they are not predicted to) also have higher R&D than predicted. The third specification controls for the endogeneity of the board independence index and of its interaction with the indicator of corruption. The Cragg-Donald test[30] confirms that the instruments are not weak at 5%[31] while the over-identification test does not reject the hypothesis that our instruments are exogenous. We have tested for the misspecification of the outcome equation due to omitted variables and the result of the test suggests there is no misspecification (the p-value is indeed equal to 0.3053).

We start from a simple specification of the two equations where age, workers, fixed assets (all in logs) and market share are the regressors shared by both equations with the variable equity appears only in the equation on the propensity to invest in R&D[32]. The probability of reporting positive R&D is positively and significantly related to firm size but not to age. The positive correlation between firm size and the probability of performing R&D is a standard result when estimating R&D investment equations: bigger firms are more likely to be willing to bear the initial sunk costs attached to R&D investment, they have easier access to credit and they are more capable of bearing the risk related to R&D investment whose returns can be highly uncertain. However, older firms are not necessarily more likely to invest in R&D: this result can be explained by the fact that our analysis is focusing on a specific

[30] The Cragg-Donald statistics (1993) is used to evaluate the overall strength of the instruments when there are multiple endogenous variables. The null hypothesis is that the set of instruments is weak. Stock and Yogo (2005) have tabulated the critical values of the minimum eigenvalue of the Cragg-Donald statistics. To be able to calculate the critical value, it is necessary to identify the rejection rate which is tolerable in the context of the analysis. If the test statistic exceeds the critical value then the instruments are not weak.

[31] The critical values have been calculated under a rejection rate of 15%.

[32] We have tested the possibility of omitted variables in the selection equation but we find no evidence of misspecification.

group of firms, i.e. multinationals' affiliates, which may have the necessary skills and resources to invest in R&D thanks to the parent company which may decide to move skilled workers and financial resources to support the investment of R&D of an affiliate even if it has been recently established. Equity capital is positively correlated to the propensity to invest in R&D and this is consistent with the literature on the role of equity capital in supporting R&D investment. Market share is generally not significant. R&D intensity is positively related to firm size (proxied by capital intensity) as firms that use more capital-intensive technologies are more R&D intensive than those using less capital-intensive technologies. Given the fact that R&D intensity if measured as a ratio between R&D expenditure and fixed assets, this negative coefficient suggests there are decreasing returns to scale in the relationship between R&D investment and capital intensity (see also Crepon et al., 1998). Finally, the size of the network of affiliates is positively correlated with the R&D intensity confirming the view that larger multinationals tend to invest in R&D routinely.

These main results are confirmed by the second specification. In the third specification, we control for the propensity to collaborate with external organisations and this variable turns out to be positively correlated with the R&D intensity. More specifically, affiliates that cooperate with external organizations for the purpose of developing an innovation have an R&D intensity which is much higher than the one recorded for affiliates which do not collaborate with other organisations. We also control for the propensity to register valuable patents (proxied by the number of forward citations) in the past and find that they are not significant suggesting that the "success-breed-success" hypothesis may not be relevant to our sample. R&D investment taking place in a single affiliate is no longer correlated with the size of the network of affiliates controlled by a multinational suggesting that most of the variation in R&D intensity among affiliates is explained by other characteristics of the affiliates.

Finally, in the last specification, we introduce the dummy taking the value of one if more than 50% of the shares are owned by companies from Common Law countries. This variable is interacted with our indicator of corruption to capture the fact that companies in corrupt countries may benefit more from concentrated ownership of multinationals from Common Law countries thanks to the quality of their corporate governance system. This variable is significant on its own while the interaction term is not. The coefficient indicates that affiliates whose majority of shares is controlled by shareholders from Common Law countries have a much higher R&D intensity than the only partially controlled affiliates have. This result is not surprising: there exists a lot of evidence suggesting that R&D performing affiliates tend to be fully controlled by their parent companies for a variety of reasons discussed in Section 2 (see Driffield et al., 2014). We also introduce in the R&D intensity equation our variables of interest, namely the indicator of the independence of the board, the dummy of perceived level of corruption and their interaction. These variables are jointly significant in the R&D intensity equation (at 1%). The dummy that controls for the size of the board is not significant suggesting that most of the variation in R&D intensity is explained by the composition of the board rather than by its size. From the values of the coefficients, it appears that as corruption decreases (i.e. the control of corruption index is above 1.5), the relationship between the R&D intensity and the board independence changes. The values are shown in Table 7. The value of the coefficient decreases as corruption reduces and when the control of corruption index is above 1.5, the coefficient associated to the board independence index becomes negative, i.e. it is equal to -2.32.

These results shed some light on how multinationals manage the board structure when investing in corrupt countries. Independent boards are clearly valued by multinationals in those environments and mostly because of the intensity of their monitoring. However, independent boards may be weak when trying to advice the senior management. The results suggest that multinationals try to compensate for the loss in the quality of the advice by drawing independent directors from the pool of (either female or young or foreign) executives in the same industry. This compensation mechanism is not a perfect substitute for appointing inside directors who may have a more complete understanding of how the company operates and what makes a R&D project successful. Indeed, in countries with low levels of corruption, the benefits of having a largely independent board are very small and are overshadowed by their costs which are associated to the fact that independent directors may lack the specific knowledge of the company to be able to advice the senior management effectively. In corrupt countries, however, the benefits of having an independent board more than compensate the costs of having independent directors.

Stage 2. We consider next the estimates of the two innovation equations discussed in Stage 2. The Maximum Likelihood estimates are reported in Table 8 with the first column reporting the model where the dependent variable is the patent counts by year while the second column reports the model where the number of forward citations is our dependent variables. The over-dispersion coefficient (α) is significant supporting the choice of the Negative Binomial model. We used two specifications: the first one attempts to control for the past patenting/citations activities of the company (through a set of dummies) while a second one does not include these variables. As the variables are not significant and the estimates do not differ significantly, we focus on the second set of estimates.

As expected, the R&D intensity variable, taken at its predicted values from the last specification of the Heckman model, is positively correlated with the probability of registering a patent[33]. The magnitude of this coefficient indicates a robust result throughout each of the specifications. In the literature on knowledge innovation functions, coefficients in the range of 0.4 and 1.1 are typically found. Our estimate of coefficients of the R&D variable is below this range but still close to the lower bound. The R&D intensity affects positively the forward citations counts as we would expect although the coefficient is much smaller. Firm's size is positively correlated with the innovation output - conditional on innovation input (R&D) - as large firms tend to register more patents than small innovative firms. Age is significant in the patent counts

[33] We have tested whether our governance variables could contribute to explain the variation in the counts of the patents and citations while controlling for the predicted R&D but these variables have turned out to be insignificant while the predicted R&D intensity still was.

equation only suggesting that while old firms may invest more in R&D and register more patents, they may not have more valuable patents. This result is rather standard in the innovation literature and it is usually explained by the fact that older firms may carry out some routine R&D which may not necessarily be linked to the actual production of a valuable innovation. Capital intensity has a positive sign and it is significant in both equations suggesting that more capital-intensive firms tend to have more valuable patents.

4.1 Robustness tests

In this section, we present the results of a set of additional tests that aim at gauging the robustness of the main results from the previous section. We only present the results relative to the main variables of interest from the R&D investment equations for brevity unless indicated otherwise.

4.1.1. Demographic characteristics of the directors

While a large literature in corporate governance has focused on the independence of the board and its relationship with the performance of the company, an even larger literature has focused on the demographic characteristics of the directors (Johnson et al, 2013). In particular age has received a lot of attention. Age is usually considered a proxy for experience with the result that a positive relationship with the firm-level performance is expected. However, some authors have pointed out that age may also be an indicator of risk aversion (Platt and Platt, 2012) and this may be quite relevant to our case as investing in R&D can be a risky pursuit with uncertain outcomes. In other words, we could expect that younger (and possibly inexperienced) directors may end up approving R&D projects that are risky and probably not very productive.

Given the literature, we have tested whether companies whose directors are below fifty years old tend to invest more in R&D. To this purpose, we have constructed a dummy variable taking the value of one if average age of directors on the board is below fifty years old. We have introduced this variable in the

R&D investment equations and the results are shown in the first column of Table 9. The dummy variable is not significant suggesting that companies with directors whose average age is less than fifty may not necessarily invest more in R&D.

4.1.2 Foreign connections of the directors

There exists a large literature that examines how the directors' social relationships (both personal and business relationships) may affect the board dynamics and eventually the firm's performance (Johnson et al., 2013). It has been argued that social relationships may affect the incentives of the directors to monitor the management and may eventually compromise the independence of the board (see for instance, Ruigrok et al., 2006). In the case of multinationals, a "desirable" board for subsidiaries operating in corrupt countries may not be an independent board *per se* but rather a board made of directors who have no connections with the local environment as they are less likely to be corruptible and more likely to closely monitor the local management. To test whether this is the case, we have computed for each board the proportion of directors who have ties only with foreign firms (but not with local firms) and created a variable taking the value of one if more than fifty percent of the directors have only connections with foreign firms. We have introduced this variable among the regressors in the R&D investment equations and the results (shown in the second column of Table 9 – Column 2) suggest that the variable is not significant while the main results still hold. In other words, independence of the board (defined in the usual way) still matters for well-performing affiliates.

4.1.3 The Institutional Environment

How robust are our results to the introduction of indicators of the quality of institutions in the outcome equation? A large literature on public governance suggests that corruption is really the expression of dysfunctional institutions hinting at the possibility that the main result may not hold any longer once we control for government effectiveness. In our context, government effectiveness is defined as in Hellman et al. (2000) and captures the perception of the quality of public services and of the civil service as well as its independence from political pressure. Therefore, we add to our R&D investment equations the World Bank indicators of government effectiveness (presented in the descriptive statistics) to test the robustness of our main results. The results are presented in Table 9 (Column 3) and they show that the indicator of government effectiveness is not significant while the main variables of interest are still jointly significant.

4.1.6 Other Institutional Variables

In the section on descriptive statistics, we have discussed the relationship between the percentage of independent directors in a board and some characteristics of the institutional environment (Legal Origin index – LLSV - , revised anti-director index and Law and Order index) of the host country. In this section, we test whether the same indicators mediate the relationship between the relative independence of the board and the affiliates' R&D intensity. Indeed it could be argued that as corruption is the outcome of dysfunctional institutions, then structural indicators of the key characteristics of the local institutions can better capture the nature of the relationship between R&D intensity and structure of the board. We have therefore interacted our measure of board independence with each of the three institutional indicators reported above while controlling for the ownership structure (in turn interacted with each of the three indicators as well). The results are reported in Table 10 (Column 1 for the LLSV index, Column 2 for the revised anti-director index and Column 3 for the Law and Order index) and in each case the variables both in level and interacted are not significant suggesting that the variation of the R&D intensity across countries and over time cannot be simply explained by the structural characteristics of the local institutions.

5. CONCLUDING REMARKS

This paper has analysed the relationship among the independence of the board of directors, country-level corruption and innovation in 4,100 manufacturing subsidiaries belonging to British multinationals and located in 30 countries. The sample period is between 2005 and 2013. Although there is a voluminous literature on the relationship between corporate performance, characteristics of the board and the legal environment, so far no study has analysed how effective independent boards are in corrupt environments in insulating a company from corruption. To model the relationship between corruption, innovation and independence of the board, we have estimated an innovation production function that links innovation outputs to innovation input (namely investment in R&D) after controlling for the subsidiary's characteristics and the levels of perceived corruption in the host country. The results show that subsidiaries located in more corrupt countries with more independent boards tend to invest more in R&D and register more valuable patents. However, it is important to notice that the benefits of an independent board decrease as corruption reduces: this result can be explained by the fact that independent directors may lack the specific knowledge of the company's operations which may be detrimental to the company.

This paper contributes to the existing literature in this area in several ways. First, our findings suggest that independent directors who can monitor the local management can limit the inefficiencies associated with operating in a corrupt country. Importantly, the paper shows that other ways of structuring the board of directors may not be as effective as independence in insulating affiliates from the negative impact of corruption. Indeed, this result still holds when we control for the age of the directors which indicates that more experienced directors may not make irrelevant the role that the independence of the board can play in protecting the company from corruption. The same applies when controlling for the proportion of directors who have no connections with local firms implying that the lack of understanding of the local context may not help the company. Second, it shows that the operating environment of a company may be a strong conditioning factor when owners decide on the structure of the board. Indeed, our results show that R&D performing firms that theoretically should benefit from the quality of the advice of a less independent board still prefer independent boards when investing in corrupt countries. Finally, the results shed some light on how multinationals manage the trade-off between the advising function and the monitoring function in corrupt countries. Indeed, in corrupt countries, multinationals prioritise the monitoring function to the advising function and prefer to have independent boards to guarantee a certain level of monitoring intensity. This strategy comes with a loss of the quality of the advice from the board but at the same time it pays off as affiliates with more independent boards tend to be more R&D intensive and innovative. However, this strategy is not useful to multinationals that invest in countries with low levels of perceived corruption. In these cases, the costs associated to the low quality of the advice from the board overshadow the benefits of having a board mostly composed by outside directors with limited understanding of the company's operations.

Table 1. *Basic Descriptive Statistics*

Country	*Equity*	*Workers*	*R&D intensity*	*Patents*	*Forward citations*	*External collaborators*
Austria	5.951	133	0.199	1	3	0.1
	2.107	146.152	0.300	5.4	16.4	0.7
Belgium	7.534	293	0.250	11	34	2
	3.083	997.005	0.327	63.5	264.6	13.3
Bosnia and Herzegovina	7.061	70	0.001	0.1	0	0
	0.831	10.162	0.002	0.1	0.0	0.0
Bulgaria	8.240	517	0.064	0.2	0	0
	2.826	358.373	0.139	0.3	0.4	0.0
Croatia	4.663	52	0.045	0.1	0	0
	3.388	19.748	0.072	0.1	0.0	0.0
Czech Republic	6.679	318	0.084	0.2	0.4	0
	3.042	614.905	0.180	1.6	2.8	0.3
Denmark	6.636	126	0.351	2	7	0.7
	2.242	130.386	0.375	6.8	29.9	1.8
Estonia	3.084	59	0.107	0.1	0	0
	1.780	54.673	0.177	0.1	0.0	0.0
Finland	6.835	97	0.358	2	3	0.5
	2.074	120.666	0.336	4.7	9.8	1.9
France	7.283	207	0.250	0.3	0.5	0
	2.367	445.885	0.324	1.1	3.0	0.4
Germany	5.885	269	0.177	3	13	0.7
	2.445	842.057	0.272	18.3	85.8	6.0
Greece	7.680	140	0.104	0.2	0.1	0
	1.459	86.890	0.181	0.1	1.0	0.0
Hungary	7.795	266	0.072	0.1	0	0
	2.202	230.469	0.117	0.1	0.0	0.0
Ireland	6.610	58	0.475	0.2	0.6	0.1
	1.991	57.771	0.415	1.1	3.1	0.5
Italy	6.427	178	0.270	0.3	0.8	0.1
	2.533	364.887	0.319	1.7	7.6	0.9
Latvia	6.384	78	0.084	0.2	0	0
	1.660	21.069	0.095	0.3	0.0	0.0
Lithuania	5.173	135	0.012	0.1	0	0

	3.821	60.926	0.016	0.2	0.0	0.0
Luxembourg	9.216	148	0.035	0.4	5.9	0.3
	2.173	100.577	0.048	2.2	30.2	1.8
Malta	2.887	167	0.334	0.1	0	0
	1.686	268.173	0.376	0.3	0.0	0.0
Netherlands	5.109	166	0.318	0.5	0.8	0.1
	2.869	221.943	0.367	2.7	4.6	0.5
Norway	6.257	75	0.359	0.4	0.4	0.1
	2.368	104.110	0.301	1.8	2.8	0.5
Poland	7.247	304	0.064	0.1	0	0
	2.512	491.429	0.153	0.1	0.0	0.0
Portugal	7.022	114	0.269	0.3	0	0
	1.848	114.480	0.343	0.2	0.0	0.0
Romania	6.777	615	0.033	0.1	0.1	0
	2.855	1266.438	0.056	0.2	0.9	0.0
Russian Federation	6.595	783	0.113	0.1	0	0
	2.210	974.973	0.202	0.3	0.0	0.0
Serbia	8.259	121	0.107	0.1	0	0
	1.262	89.556	0.183	0.2	0.0	0.0
Slovakia	8.354	505	0.070	0.1	0	0
	2.659	746.656	0.158	0.2	0.0	0.0
Slovenia	5.845	86	0.238	0.5	1.4	0.8
	1.978	118.313	0.274	1.7	5.2	2.7
Spain	6.730	230	0.208	0.1	0.2	0
	2.441	478.811	0.278	0.8	1.9	0.4
Sweden	5.355	516	0.360	92	186	25
	2.839	1573.063	0.380	482.4	925.8	145.2
Ukraine	6.915	328	0.044	0.1	0	0
	1.754	279.991	0.068	0.1	0.0	0.0
Total	6.583	256	0.212	5	11	1
	2.609	689.824	0.301	90.1	184.1	26.9

Source: Amadeus and World Patents Databases. Authors' calculations. Mean is reported on the first row while the standard deviation is reported below the mean.

Table 2. *Matrix of Correlations*

	Equity	*Workers*	*R&D intensity*	*Patents*	*Forward citations*	*External collaborators*	*Control of corruption*	*A*
Equity	1.00							
Workers	0.33	1.00						
R&D intensity	-0.14	-0.09	1.00					
Patents	0.11	0.50	-0.02	1.00				
Forward citations	0.13	0.52	-0.02	0.87	1.00			
External collaborators	0.09	0.39	-0.02	0.71	0.89	1.00		
Control of corruption	-0.11	-0.03	0.16	0.07	0.07	0.06	1.00	
Age	0.24	0.15	-0.11	0.14	0.14	0.13	0.19	1.
Ownership (1/0)	-0.06	-0.01	0.01	0.04	0.04	0.04	0.05	0.

Figure 1. *Control of Corruption index by country and year.*

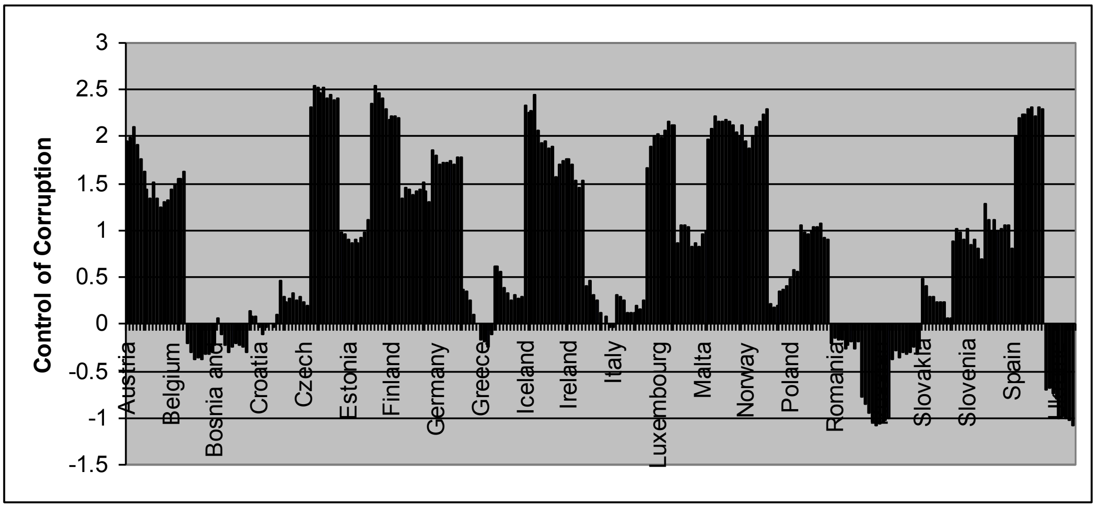


Figure 2. *R&D Intensity by country and year.*

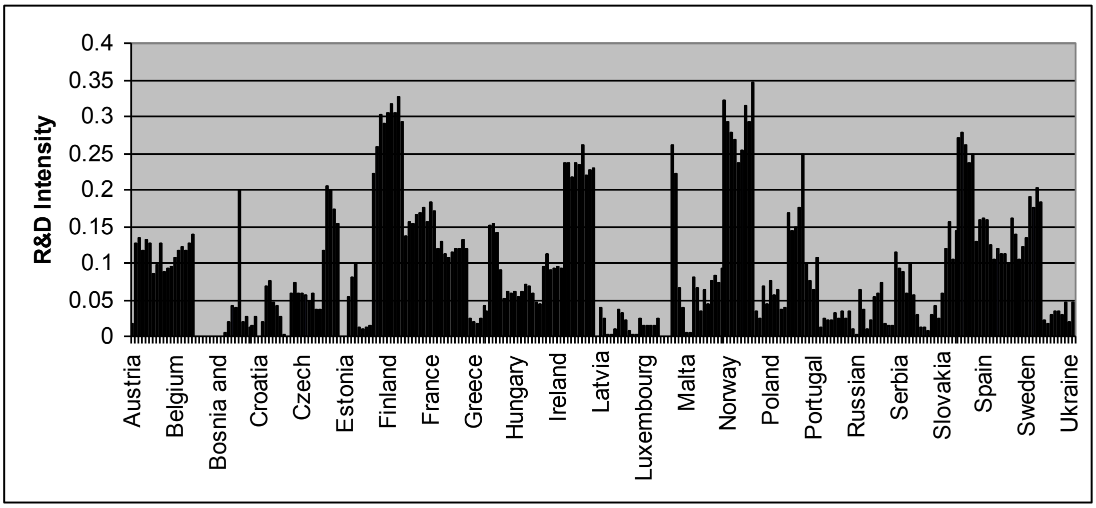


Figure 3. *Percentage of shares owned by UK parent companies, by country.*

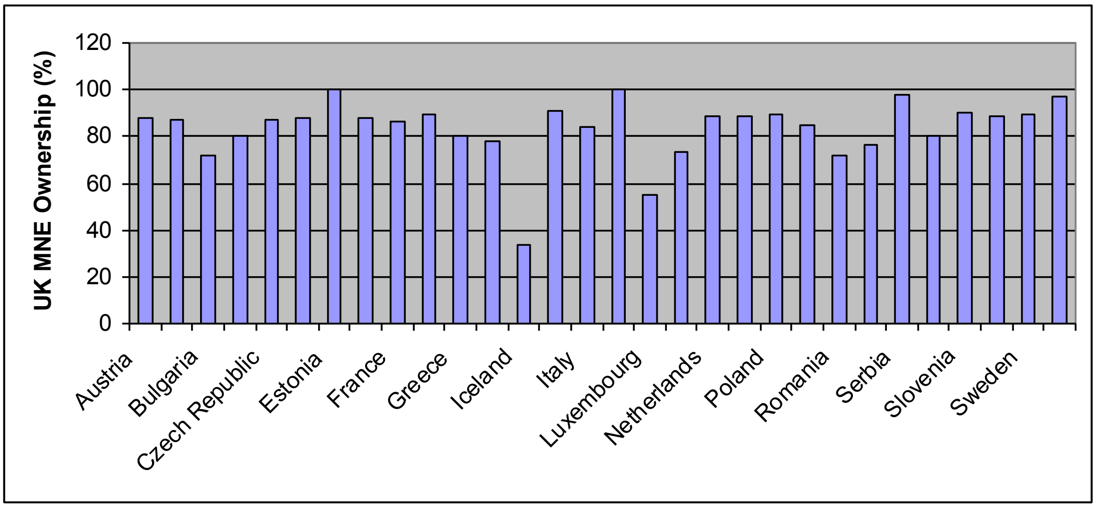


Figure 4. *Board Independence index by country and year.*

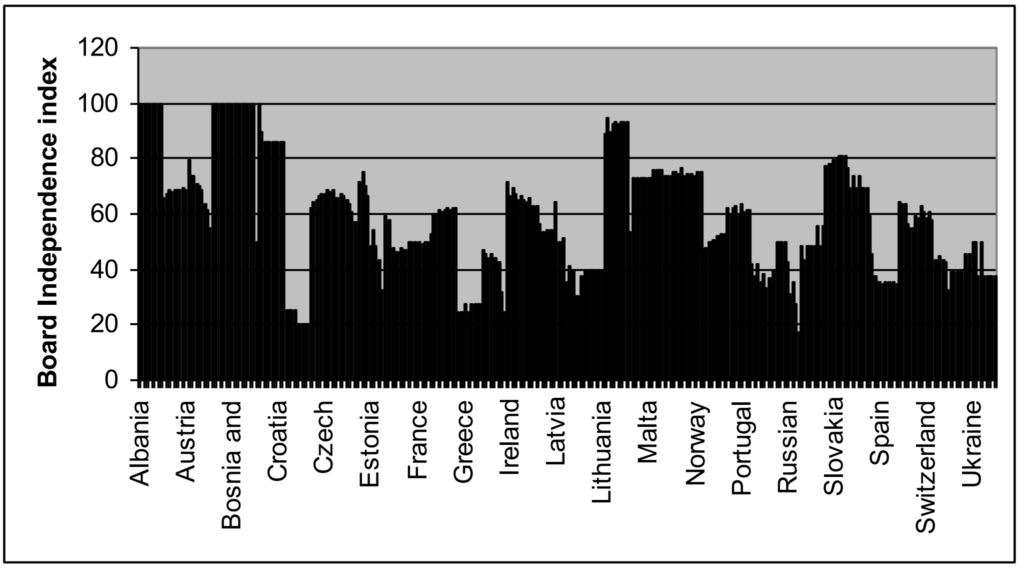


Table 3. *Legal tradition of countries included in the sample.*

Legal Tradition	Countries
Common Law countries	Ireland (62), Malta (53).
Civil Law countries	Belgium (62), France (45), Greece (27), Italy (51), Luxembourg (93), Netherlands (54), Portugal (65), Spain (21).
Scandinavian Law countries	Denmark (51), Finland (61), Norway (67), Sweden (55).
Germanic Law countries	Germany (52), Austria (57).

Note: The table classifies the countries in the sample according to their legal tradition using the indicator developed by La Porta et al. (1998). The country/time average of the percentage of outside directors among foreign affiliates in the sample is in parentheses.

Table 4. *Revised Anti-Director Rights Index*

Revised anti-director rights index	Countries
2	Greece (27), Hungary (37), Italy (51), Luxembourg (93), Poland (51).
2.5	Austria (57), Croatia (80), Netherlands (54), Portugal (65).
3	Belgium (62), Bulgaria (90), Slovakia (83), Ukraine (50).
3.5	Finland (61), France (45), Germany (52), Norway (67), Sweden (55).
4	Czech Republic (60), Denmark (51), Latvia (28), Lithuania (25).
5	Ireland (62), Romania (42), Spain (21).

Note: The table classifies the countries in our sample according to the values of the revised Anti-Director Rights index calculated by Djankov et al. (2008). The index summarises the extent to which legislation protects the minority shareholders in the corporate decision-making process. Larger values of the index are associated to countries whose legislation is more favourable to minority shareholders. The country/time average of the percentage of outside directors among foreign affiliates in the sample is in parentheses.

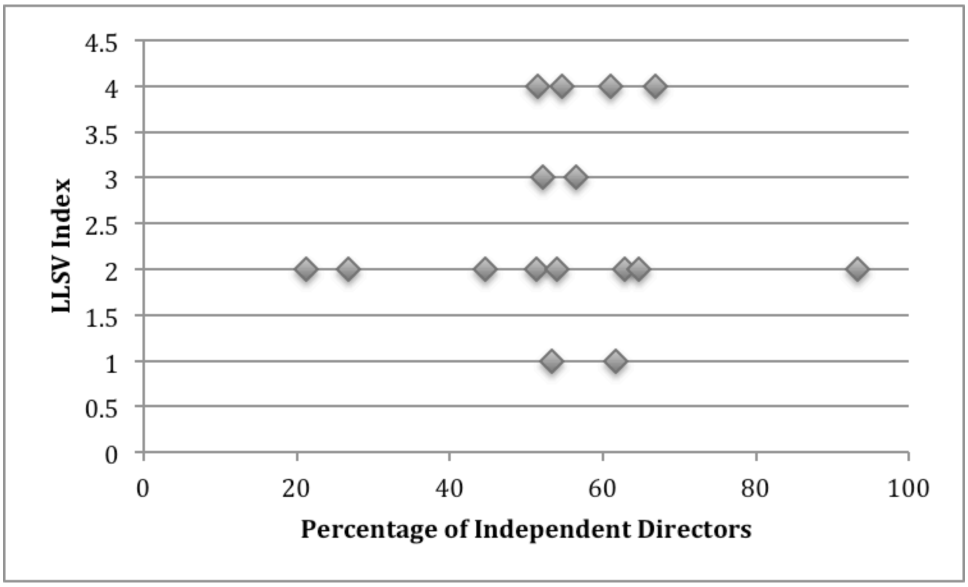
Table 5. *ICRG Law and Order Index*

Law and Order Index	Countries
3	Bulgaria (90)
4	Romania (42), Estonia (55), Hungary (37), Italy (51), Slovakia (83), Ukraine (50).
4.5	Poland (51), Greece (27), Slovenia (75), Croatia (80).
5	Belgium (62), Czech Republic (60), France (45), Germany (52), Latvia (28), Malta (53), Portugal

	(65), Spain (21).
6	Austria (57), Denmark (51), Finland (61), Ireland (62), Luxembourg (93), Netherlands (54), Norway (67), Sweden (55).

Note: The table classifies the countries in our sample according to the values of the ICRG Law and Order Index. The index summarises the extent to the legal system is impartial and law is generally observed within the country. Larger values of the index are associated to less risky countries. The country/time average of the board independence indicator is in parentheses.

Figure 5. *Board Independence index vs LLSV index*



Note: 1 refers to the Common Law countries, 2 refers to the countries from the Civil Law tradition, 3 refers to countries from the Germanic legal tradition while 4 refers to the countries from the Scandinavian legal tradition.

Figure 6. *Board Independence index (i.e. percentage of outside directors) vs. the Revised Anti-director index*

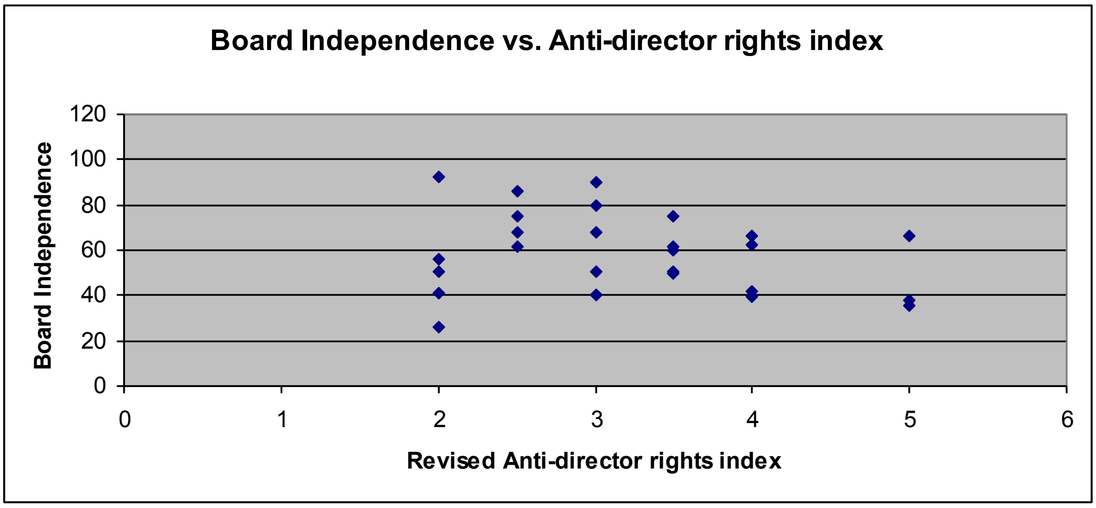


Figure 7. *Board Independence index (i.e. percentage of outside directors) vs the ICRG Law and Order index*

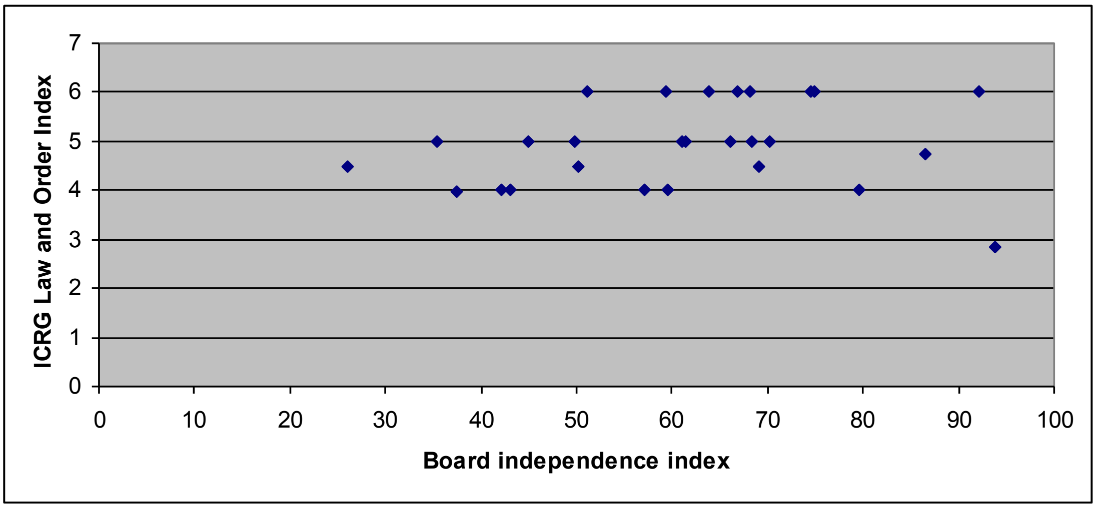


Table 6. *Stage 1: R&D investment – Heckman model*

R&D intensity (log)	**Model 1**	**Model 2**	**Model 3**
	Coefficient (t-ratio)	*Coefficient (t-ratio)*	*Coefficient (t-ratio)*
Number of subsidiaries	0.060 (3.18)	0.047 (2.13)	-0.033 (-1.27)
Age (log)	-0.62 (-5.75)	-0.64 (-5.48)	-0.43 (-6.30)
Fixed Assets intensity (log)	-0.70 (-3.79)	-0.71 (-3.72)	-0.66 (-2.68)
Size of the board (1/0)		0.17 (1.31)	-0.147 (-0.64)
Market Share	-0.0088 (-0.51)	-0.0086 (-0.52)	0.013 (1.23)
Collaborating with an external organisation (1/0)			0.79 (2.46)
Forward citations (1/0) - t-1		0.40 (1.22)	-0.032 (-0.07)

Forward citations (1/0) - t-2		0.76	0.13
		(2.77)	(0.31)
Forward citations (1/0) - t-3		1.08	0.56
		(4.93)	(1.20)
Forward citations (1/0) - t-4		1.047	0.64
		(4.50)	(1.27)
Forward citations (1/0) - t-5		0.29	0.37
		(1.12)	(0.69)
Forward citations (1/0) - t-6		0.044	0.12
		(0.15)	(0.23)
Forward citations (1/0) - t-7		0.84	0.80
		(3.66)	(1.45)
Forward citations (1/0) - t-8		1.065	0.92
		(2.42)	(1.46)
Majority Owners from Common Law countries (1/0)			0.35
			(2.58)
*Majority Owners from Common Law countries (1/0)*Control of Corruption (1/0)*			-0.30
			(-1.18)
Control of Corruption (1/0)			3.74
			(2.68)
Share of Independent Directors			1.59
			(2.53)
*Control of Corruption (1/0) * Share of Independent Directors*			-3.91
			(-2.82)
Constant	-6.83	-6.83	-7.83
	(-11.13)	(-11.13)	(-7.82)
Propensity to invest in R&D (1/0)			
Fixed Assets (log)	0.090	0.090	0.090
	(2.57)	(2.57)	(2.57)
Equity (log)	0.024	0.024	0.024
	(5.81)	(5.81)	(5.81)
Workers (log)	0.37	0.37	0.37
	(46.88)	(46.88)	(46.88)
Age (log)	-0.22	-0.22	-0.22
	(-13.16)	(-13.16)	(-13.16)
Market Share	-0.0017	-0.0017	-0.0017
	(-0.33)	(-0.33)	(-0.33)
Constant	-1.44	-1.44	-1.44
	(-20.30)	(-20.30)	(-20.30)
p-value	0.0001	0.0003	0.0001
Cragg-Donald test			5.42
Test of Overidentifying Restrictions (p-value)			0.10
N	23287	23287	23287

Note: Two-step estimates with t-ratios in parentheses. Bootstrapped standard errors clustered around the host country. Panel A shows the estimates of the outcome equation (R&D intensity equation) while Panel B shows the estimates of the selection equation (propensity to invest in R&D). The period of analysis is 2005-2013. Year, country and industry dummies are included in all the specifications. The p-value is the result of significance test of the Inverse Mills Ratio (IMR). Model 3 has been estimated using an IV estimator with the IMR used to correct for the sample selection. The instruments include: a) the average proportion of foreign executives with no local business connections that work for other multinationals in the same 3-digit industry, country and year, b) the density of multinationals in the same region (NUTS2), country and year and c) the proportion of female executives below 50 years old who work for other multinationals in the same 3-digit industry, country and year. The test on overidentifying restrictions is the Sargan test while the Cragg-Donald test is significant at 5% (with the critical value calculated for a rejection rate of 15%).

Table 7. *Coefficient of the board independence index*

	Coefficient associated to the board independence index
Control of corruption is larger than 1.5	-2.32
Control of corruption is less than 1.5	1.59

Table 8. *Stage 2: Patents and Citations Counts – Negative Binomial regression*

	Patents counts	**Citations Counts**
	Coefficient (t-ratio)	*Coefficient (t-ratio)*
Capital Intensity (log)	3.79	2.47
	(1.63)	(1.67)
Workers(log)	1.22	1.23
	(8.01)	(12.39)
Age(log)	0.13	-0.19
	(0.83)	(-0.68)
Predicted R&D Intensity	0.30	0.22
	(3.09)	(3.26)
Constant	4.02	-1.74
	(-3.68)	(-1.39)
A	0.030	1.053

Note: Maximum Likelihood estimates with t-ratios in parentheses. Standard errors have been clustered around the country. Column 1 shows the estimates of the patent counts regression while Column 2 shows the estimates of the citation counts estimates. The period of analysis is 2005-2013. Year, country and industry dummies are included in all the specifications. α is the dispersion parameter of the negative binomial regression.

Table 9. *Robustness Tests: the role of age, foreign connections of the directors and government effectiveness*

R&D intensity (log)	Model 1	Model 2	Model 3
	Coefficient (t-ratio)	*Coefficient (t-ratio)*	*Coefficient (t-ratio)*
Age of directors above 50 (1/0)	-0.0052		
	(-0.46)		
Foreign Connections (1/0)		0.12	
		(0.87)	
Government Effectiveness			0.006
			(0.01)
Majority Owners from Common Law countries (1/0)	0.33	0.31	0.33
	(2.46)	(2.46)	(2.44)
Majority Owners from Common Law countries (1/0) Control of Corruption (1/0)*	-0.15	-0.14	-0.155
	(-0.66)	(0.63)	(-0.67)
Control of Corruption (1/0)	3.095	3.03	3.12
	(2.23)	(2.27)	(2.30)
Share of Independent Directors	1.48	1.42	1.48
	(2.18)	(2.26)	(2.16)
*Control of Corruption (1/0) * Share of Independent Directors*	-3.18	-3.14	-3.22
	(-2.33)	(-2.38)	(-2.41)
Constant	-7.79	-7.93	-7.84
	(-7.54)	(-7.76)	(-7.70)
p-value	0.000	0.000	0.000
Cragg-Donald test	5.36	5.92	5.43
Test on Overidentifying Restrictions (p-value)	0.104	0.109	0.10

Note: Panel A shows the estimates of the outcome equation (R&D intensity equation). Model 1 models the relationship between the age of the directors and the investment in R&D while Model 2 refers to the relationship between the proportion of directors with foreign only connections and the R&D investment. Model 3 control for the government effectiveness. Two-step estimates with t-ratios in parentheses. Bootstrapped standard errors clustered around the host country. The period of analysis is 2005-2013. Year, country and industry dummies are included in all specifications. The p-value is the result of significance test of the Inverse Mills Ratio (IMR). All models have been estimated using an IV estimator with the IMR used to correct for the sample selection. The instruments include: a) the average proportion of foreign executives with no local business connections that work for other multinationals in the same 3-digit industry, country and year, b) the density of multinationals in the same region (NUTS2), country and year and c) the proportion of female executives below 50 years old who work for other multinationals in the same 3-digit industry, country and year. The test on overidentifying restrictions is the Sargan test while the Cragg-Donald test is significant at 5% (with the critical value calculated for a rejection rate of 15%).

Table 10. *Robustness tests – Other institutional variables*

R&D intensity (log)	Model 1	Model 2	Model 3

	Coefficient (t-ratio)	*Coefficient (t-ratio)*	*Coefficient (t-ratio)*
Majority Owners from Common Law countries (1/0)	-0.48	1.42	5.22
	(-0.41)	(1.63)	(0.85)
Majority Owners from Common Law countries (1/0) LLSV*	0.76		
	(0.64)		
Majority Owners from Common Law countries (1/0) Revised Anti-director index*		-0.41	
		(-1.42)	
Majority Owners from Common Law countries (1/0) Law and Order index*			-1.12
			(-0.82)
LLSV	-10.36		
	(-1.06)		
Revised Anti-director index		8.85	
		(5.96)	
Law and Order index			17.92
			(0.65)
Share of Independent Directors	-12.01	4.13	92.23
	(-1.18)	(0.92)	(0.67)
*LLSV * Share of Independent Directors*	12.38		
	(1.18)		
*Revised Anti-director index * Share of Independent Directors*		-1.08	
		(-0.93)	
*Law and Order index * Share of Independent Directors*			-18.83
			(-0.67)
Constant	9.76	13.23	-94.57
	(0.93)	(2.05)	(-0.67)

Note: Panel A shows the estimates of the outcome equation (R&D intensity equation). In Model 1, the relationship between LLSV and the investment in R&D is estimated while in Model 2 we estimate the relationship between Revised Anti-director index and the R&D intensity. In Model 3 we estimate the relationship between the Law and Order index and R&D intensity. Two-step estimates with t-ratios in parentheses. Bootstrapped standard errors clustered around the host country. The period of analysis is 2005-2013. Year, country and industry dummies are included in all specifications. The p-value is the result of significance test of the Inverse Mills Ratio (IMR). All models have been estimated using an IV estimator with the IMR used to correct for the sample selection. The instruments include: a) the average proportion of foreign executives with no local business connections that work for other multinationals in the same 3-digit industry, country and year, b) the density of multinationals in the same region (NUTS2), country and year and c) the proportion of female executives below 50 years old who work for other multinationals in the same 3-digit industry, country and year.

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